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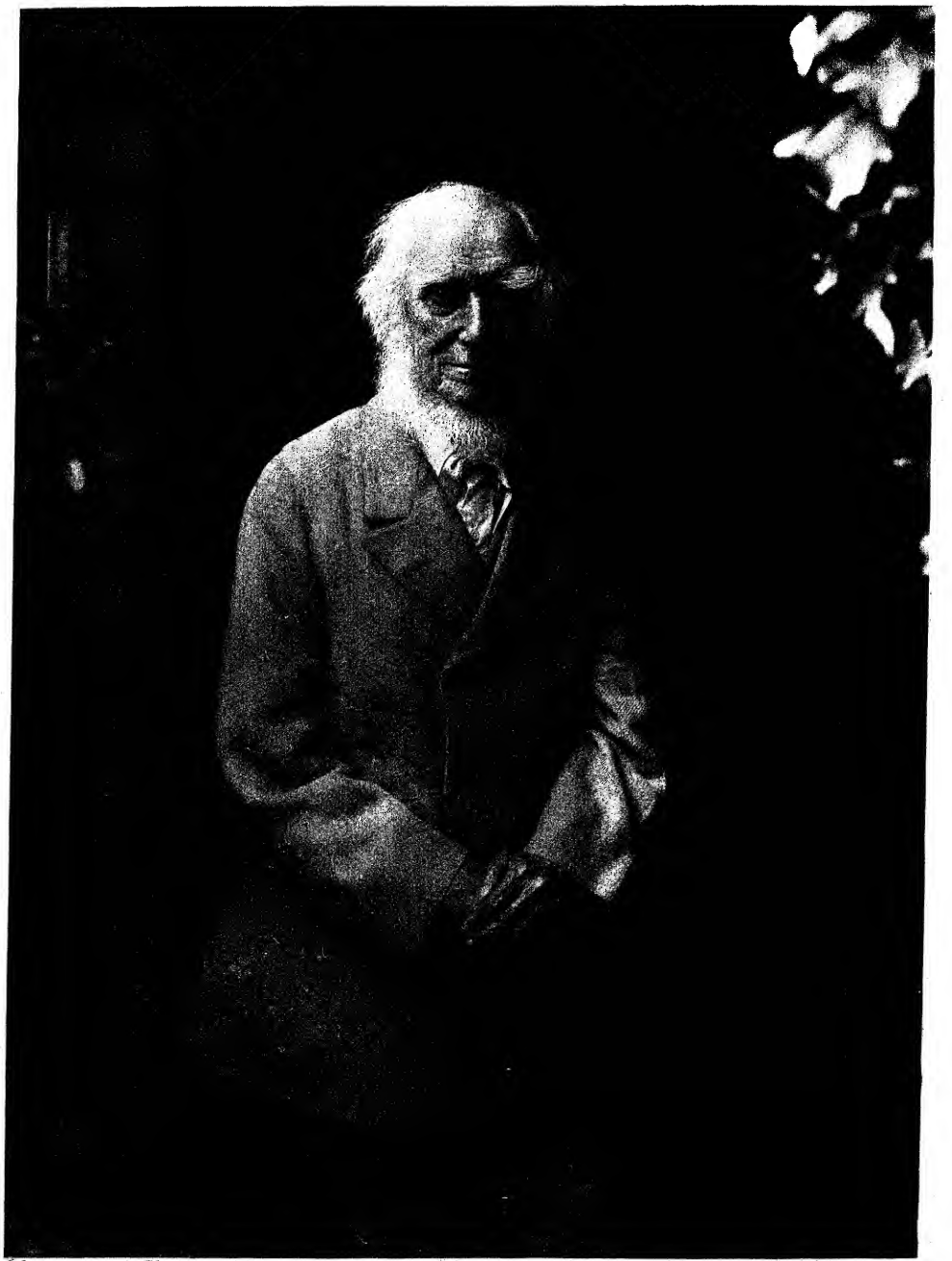

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SIR JOSEPH DALTON HOOKER,* 1817—1911.

JOSEPH DALTON HOOKER, the younger son of Sir William Jackson Hooker, Regius Professor of Botany in the University of Glasgow, afterwards Director of the Royal Botanic Gardens, Kew, and his wife Maria, eldest daughter of Dawson Turner, F.R.S., banker, of Great Yarmouth, Norfolk, was born at Halesworth, Suffolk, June 30, 1817.

Sir William Hooker (*d.* 1865) was himself the younger son of Joseph Hooker, a native of Exeter, where he had been in the employ of Baring Brothers, woolstaplers, with whose family he was distantly connected, and had afterwards gone into business at Norwich. There he married Lydia, daughter of James Vincent, worsted manufacturer, grandfather of George Vincent, the artist. Joseph Hooker was seventh in descent from John Hooker, *alias* Vowell, editor of 'Holinshed's Chronicles,' and uncle of Richard Hooker, the theologian.

At the end of the eighteenth and beginning of the nineteenth centuries the Eastern Counties possessed a rather remarkable amount of local intellectual activity. It developed a notable school of artists, and indirectly fostered the career of many men who attained distinction in various ways. Of this activity Dawson Turner was in some sense a moving spirit. He had himself acquired scientific fame by his botanical work, and he had been the judicious and fortunate collector of a gallery of pictures which have been dispersed, but some of which have found a permanent home in the National Gallery and the Wallace Collection. The facts of heredity are always worth noting, and the descendants of Dawson Turner afford abundant instances. Joseph Hooker was a collector and cultivator of "Succulent Plants." Sir Joseph Hooker thought that his father "presumably derived his love of plants from his father's side, and his artistic powers from his mother's." He, himself, conspicuously inherited both.

In William Hooker's case, Sir Joseph thought that it was a visit to Dawson Turner "which led to the colouring of his future life." He succeeded through the death of a cousin, William Jackson, to a property in Kent, which, had it remained in the family, would have been the source of considerable wealth. Visiting London, he made the acquaintance of Sir Joseph Banks who introduced him into its scientific society. At his suggestion, he visited Iceland, and narrowly escaped death by the burning of the ship on which he was returning. Other prospects of travel in the tropics were frustrated.

* A fairly complete record of the life of Sir Joseph Hooker could be compiled from the five admirable volumes devoted to the life and correspondence of his father by Dr. Francis Darwin. They have been freely drawn upon. The following abbreviations are used: L.L., 'Life and Letters of Charles Darwin,' 3 vols., 1887; M.L., 'More Letters of Charles Darwin,' 2 vols., 1903; H.L.L., 'Life and Letters of Thomas Henry Huxley,' 2 vols., 1900, which is also quoted.

Without capacity for business he was induced to join Mr. Paget (father of Sir James and Sir George) in a brewery at Halesworth. The venture was unsuccessful; he had sold his property and other "investments were disappointing"; with a wife and four children he found himself crippled by a lavish expenditure on his scientific publications and indulgence in a costly library. He was therefore glad to accept, through the influence of Sir Joseph Banks, the Regius Chair of Botany at Glasgow which had been declined by Robert Brown.

At Glasgow, Joseph Hooker received at the High School the old-fashioned Scotch liberal education; it enabled him throughout life to write Latin with facility. In the University he took the M.D. in 1839, and could recall sitting on the same bench in the old building, now abandoned to a railway company, with Lord Kelvin and Lord Sandford when the father of the latter was Professor of Greek. Some of its teaching left little permanent impression. Thirty years later he said in his Presidential Address at Norwich: "Having been myself a student of Moral Philosophy in a Northern University, I entered on my scientific career full of hopes that Metaphysics would prove a useful mentor, if not a guide in science. I soon, however, found that it availed me nothing."

Hooker, residing under his father's roof, had imbibed from his stimulating intercourse and teaching a passion for botanical research and a keen desire for travel and exploration as a means of extending it. This was gratified when, immediately on taking his degree, he was appointed at the age of 21 to accompany "officially as assistant-surgeon, but in reality as naturalist, the famous expedition of Sir James Clark Ross, fitted out by the Government for the purpose of investigating the phenomena of terrestrial magnetism in the south circumpolar seas." His first actual contribution to scientific literature was a description in 1837 of three new Indian mosses published in his father's "Icones Plantarum." It has been remarked that it is "a curious coincidence" that Darwin, Hooker, and Huxley each "began his scientific career on board one of Her Majesty's ships" (H.L.L., vol. 1, p. 29). It is more than curious when one reflects on the influence on scientific thought which the three men in association were afterwards to effect.

The story of the Darwinian theory unfolds itself like a drama. And there is something fateful in the way in which the three chief protagonists, to whom Sir Charles Lyell must be added, were drawn into its action. In 1839 Darwin published his 'Journal of Researches.' At the Geological Society, where he had "acted as one of the honorary secretaries," he had made Lyell's acquaintance and gave him proof-sheets. These Lyell passed on to his father, Charles Lyell of Kinnordy, a warm friend of the elder Hooker. It is hardly too much to say that this accidental circumstance effected a filiation of the work of Hooker's life to that of Darwin. Hooker tells us (L.L., vol. 2, pp. 19, 20) that the elder Lyell, "taking a kind interest in my projected career as a naturalist, had allowed me to peruse" the proof-sheets. He continues: "At this time I was hurrying on my studies, so as to take my

degree before volunteering to accompany Sir James Ross in the Antarctic Expedition, which had just been determined on by the Admiralty; and so pressed for time was I, that I used to sleep with the sheets of the 'Journal' under my pillow, that I might read them between waking and rising. They impressed me profoundly, I might say despairingly, with the variety of acquirements, mental and physical, required in a naturalist who should follow in Darwin's footsteps, while they stimulated me to enthusiasm in the desire to travel and observe." It is important to add that he "received a copy of the 'Journal' complete—a gift from Mr. Lyell—a few days before leaving England."

The Erebus and Terror, "commissioned by Captain Sir James Clark Ross, sailed from Chatham on the 29th of September, 1839." Besides magnetic survey, the collection of "various objects of Natural History" was "enjoined to the officers." Hooker was on board the Erebus with Ross, and it was his good fortune to have a captain whose own tastes were in sympathy with the work; he, indeed, "himself gathered many of the plants" which Hooker subsequently described, and his "private cabin and library were unreservedly placed at his (Hooker's) disposal." The expedition finally gained "the Cape of Good Hope on the 4th of April, 1843, within two days of three years after they had first quitted that port for the high southern latitudes."

On his return, Hooker lost no time in commencing the publication of the botanical results of the expedition. The whole work extended to six quarto volumes, with 2214 pages and 528 plates. The Treasury made a grant-in-aid of £1000 to be expended on the plates; Hooker, for his part, received no remuneration, and abandoned "all share in the proceeds of the undertaking to the publisher, who has thus been able to bring out the series at a much more moderate price than any similar work." The first of the three sections of the whole was devoted to the 'Flora Antarctica' in two volumes (1844–7). To it is prefixed a very matter-of-fact "Summary of the Voyage," which, though it was perilous enough, with a seaman's modesty, lays little stress on the fact. The words, "Both ships had a narrow escape of running foul of an iceberg, over which the sea was breaking, eighty feet high," briefly describe an incident which might have summarily closed Hooker's career. To consummate seamanship must be credited their extrication, and the fact that during the four years of the expedition only two men were lost, one by being washed overboard. There were three breaks in the voyage: one from August 16 to November 12, 1840, in Tasmania; the second, in New Zealand, from August 18 to November 15, 1841; and the third, in the Falkland Islands, from April 6 ("not having seen land for 138 days") to September 6, 1842. These afforded Hooker ample opportunities for making collections, which he afterwards worked out.

When Hooker had completed his 'Flora Antarctica,' he had only reached the age of 30; but it placed him at once in the first rank of systematic botanists. He not merely worked out his own material, but dealt with all

that had been obtained from the same area by previous explorers. The result is a classical statement of a problem in geographical distribution which is still far from being completely solved. Writing in 1845, he thought it impossible that the plants of the Antarctic islands could "have migrated from other countries," but also thought "that islands so situated furnish the best materials for a rigid comparison of the effects of geographical position and the various meteorological phenomena on vegetation, and for acquiring a knowledge of the great laws according to which plants are distributed over the face of the globe." This is a somewhat difficult statement. But it appears to imply that distribution followed laws still to be discovered, and the further problem how plants would be modified by isolation due to geographical and physical conditions. In the first he strikes the key-note which was to dominate the whole work of his life; much happened before he saw a satisfactory solution of the second in 1866.

Although the pursuit of a definite aim runs through the bulk of all Hooker's work, it is important to recognise the fact that, like Darwin, he was essentially a naturalist. He was gifted in an extraordinary degree, especially in his early life, with keen powers of observation, a lively interest in what he observed and an aptitude for reflecting upon it. These qualities illuminate his writings, and when he turned aside, as he did from time to time, to some collateral subject, he afforded abundant evidence that, had he pursued it, he would have achieved something more than distinction. The 'Flora Antarctica' affords a striking instance. As Prof. Seward points out ('Fossil Botany,' vol. 1, p. 151), he anticipated the Challenger in discovering "the existence of masses of diatomaceous ooze over a wide area in Antarctic regions" ('Fl. Ant.,' pp. 503–6). Huxley, 40 years afterwards, wrote: "I have always looked upon Hooker's insight into the importance of these things and their skeletons as a remarkable piece of inquiry—anticipative of subsequent deep-sea work" (H.L.L., vol. 2, p. 182).

In 1839 Hooker had been introduced to Darwin in a casual meeting in Trafalgar Square. But Darwin had read with interest the letters sent home to Hooker's family and communicated to him by the elder Lyell (L.L., vol. 2, p. 20). Soon after the return of the expedition, Darwin wrote with warm congratulations, and this began a life-long friendship. What is historically of more moment is that on June 14, 1844, Darwin wrote to Hooker: "I think I have found out the simple way by which species become exquisitely adapted to various ends." "I believe," Hooker tells us, "that I was the first to whom he communicated his then new ideas on the subject." Darwin had long periods of ill-health between this and 1847, but Hooker frequently visited him; "for days and weeks the only visitor, bringing my work with me."

The relations between the two men can have few parallels in scientific history; and we owe a deep debt to Dr. Francis Darwin for the admirable volumes in which they are revealed. It is not easy to say whether the human or the scientific interest is the greater. For Darwin could write in

1856: "How strange, funny, and disgraceful that nearly all our great men are in quarrels in couplets" (M.L., vol. 1, p. 90). With Hooker, the "intimacy," which began in 1843, "ripened into feelings as near to those of reverence for his life-work and character as is reasonable and proper" (L.L., vol. 2, p. 20). Darwin, for his part, could say in 1862: "For years I have looked up to you as the man whose opinion I have valued more on any scientific subject than anyone else in the world" (M.L., vol. 2, p. 284). But it would be a great error to suppose that the terms of the friendship were merely those of mutual admiration. Writing to Lyell in 1866 Darwin said: "His (Hooker's) mind is so acute and critical that I always expect to have a torrent of objections to anything proposed: but he is so candid that he often comes round in a year or two" (M.L., vol. 2, p. 138). The moral elevation of character which made the friendship both possible and profitable is creditable to human nature; but its service to science was deeper. This has been admirably expressed by F. Darwin: "It should not be forgotten that . . . . science owes much to this memorable friendship, since, without Hooker's aid, Darwin's great work would hardly have been carried out on the botanical side; and Sir Joseph did far more than supply knowledge and guidance in technical matters. Darwin owed to him a sympathetic and inspiring comradeship which cheered and refreshed him to the end of his life" (M.L., vol. 1, p. 39).

Darwin and Hooker were both working towards evolution: but they started from different points, and travelled on lines which only slowly converged. At the beginning of the nineteenth century naturalists were still fettered by the chains which Linnæus had forged for them. Species were "diversæ formæ in principio creatæ"; they were permanent and immutable. A variation was "planta mutata a caussa accidentali"; it was not permanent, "reducitur itaque in solo mutato." Species produce individuals which therefore all trace to a common parentage, but do not vary; "produxere plures at sibi semper similes." Darwin tells us that, "when I was on board the 'Beagle,' I believed in the permanence of species" (M.L., vol. 1, p. 367). It was "the relationship between the living and the extinct mammifers in South America" (L.L., vol. 2, p. 34) which first suggested organic evolution to Darwin's mind, in the sense of the replacement in time of one allied organism by another. It was the Galapagos that suggested to him "that the inhabitants of the several islands had descended from each other, undergoing modification in the course of their descent" (Variation, vol. 1, p. 10); this was divergence in space.

Hooker equally started with a belief in the permanence of species. But he was confronted with another difficulty in the presence of the same species in widely dissevered areas. This has been held to be irreconcilable with Linnæus's dictum of a common parentage by writers as recent as the elder Agassiz. Hooker, however ('Fl. Ant.' p. 368), definitely rejected the theory of species having "multiple" or, as he called them, "sporadic" origins. The explanation then must "be sought in some natural cause." For this there are

only two alternatives: species must owe their isolation to some means of transport, the view held by Darwin and now largely accepted, though Hooker was long unable to convince himself of its efficiency; or the area occupied by the species must have been once continuous and afterwards dissevered by geological action with consequent climatic change, the explanation accepted by Hooker resting on the support of E. Forbes and Lyell. Darwin himself abandoned Lyell's views and, supported by his own observations, followed Dana in thinking that "continents as continents and oceans as oceans are of immense antiquity" (L.L., vol. 2, p. 76). The trend of recent research is probably on Darwin's side. He was deaf to Hooker's arguments, for, writing to him in 1856, he said, "You cannot imagine how earnestly I wish I could swallow continental extension, but I cannot" (L.L., vol. 2, p. 81). Hooker apparently was never really convinced, for Darwin, writing to Wallace in 1876, congratulates him on his protest "against sinking imaginary continents in a quite reckless manner, as was stated by Forbes, followed alas by Hooker" (L.L., vol. 3, p. 230).

The rejection of the theory of multiple origins seems obvious to us now. But it is important to realise that it was only arrived at cautiously and laboriously. Some years later, Alphonse de Candolle devoted at least half of his great work, 'Géographie Botanique Raisonnée' (1855) to extricating himself from a belief in it. Hooker, in fact, helped to clear the ground for a purely evolutionary theory; for if multiple origins for species are abandoned, the case for their formation by the direct action of the environment collapses as well.

During Hooker's absence on the Erebus a great change had taken place in the position of his father. A botanic garden had been created at Kew in 1759 by the Dowager Princess of Wales, and this had been actively maintained by her son George III for national purposes, with the assistance of Sir Joseph Banks. The mutiny of the Bounty was the outcome of an attempt initiated by him to introduce the bread-fruit of the Pacific into the West Indies. After the death of Banks the fortunes of Kew languished, and, on the accession of Victoria, the Government contemplated its abolition. The proposal met with strenuous opposition, and on the Report of a Committee of Enquiry, Kew as a national botanical centre was reconstituted on a larger scale. The elder Hooker had made Glasgow the seat of botanical work in Great Britain; he had amassed a vast herbarium, and was the possessor of a fine library. These, on accepting in 1841 the post of Director, were transferred to Kew, and on his death were purchased by the Government. But the change, entirely due to public spirit on his part, involved the sacrifice of half his income.

Hooker, therefore, found it necessary to seek some employment. Having acted temporarily, he was a candidate in 1845, with the support of Humboldt and Robert Brown, for the Chair of Botany at Edinburgh. Darwin was despondent at the prospect, but consoled himself with the prophecy which he lived to see vindicated—"I know I shall live to see you the first authority in

Europe on that grand subject, that almost keystone of the laws of creation, Geographical Distribution" (L.L., vol. 1, p. 336). If his unsuccess was a personal disappointment, it was a gain to science, and he was immediately (1846) appointed Botanist to the Geological Survey, in succession to Henfrey.

Hooker records in 1853 that Darwin "directed my earliest studies in the subject of the distribution and variation of species" ('Fl. N. Z.,' p. xxii). One of the first tasks he imposed upon him was the study of the flora of the Galapagos, which was to play so important a part in the development of Darwin's theory. For what it and its fauna impressed upon him was the fact of divergence due to variation and isolation. Hooker made the plants, in 1847, the subject of two papers in the 'Transactions of the Linnean Society.' In the second, he indicates two important principles: the struggle for existence and the effect of isolation, the latter being really a corollary from the former. If the species from the several islands were united in one area, "the strife with its neighbours . . . . would terminate in a few replacing the many" ('Linn. Trans.,' vol. 20, p. 259). Hence it follows that "the first steps towards ensuring the continuance of many species in a given area are to isolate them." As to the crucial problem, the affinity but divergence of the species in the several islands, he contents himself with saying that it "is a mystery which it is my object to portray, but not to explain." That he left to Darwin, whose solution he knew. But that he had some opinion of his own on the subject is evident, as in the same year he instances the Galapagos as a case "where time, the required element for developing such species as are the offspring of variation, has been granted" ('Fl. Ant.,' p. 217).

Hooker's palæontological work was more or less official, and therefore practically limited to the subjects submitted to him. These were discussed in numerous papers up to 1855, after which fossil botany ceased to occupy him. Prof. Seward has kindly examined them in detail, and, surveying them as a whole, finds that "Hooker's contributions to Palæobotany have been the means not only of throwing new light on certain extinct types, but, by their eminently philosophical spirit, of setting a high standard in a subject which has suffered greatly from unscientific treatment at the hands of less cautious contributors, insufficiently trained to appreciate the difficulties of palæobotanical research." In this sense Hooker was a pioneer in the application to such research of a rigid scientific method, which is peculiarly necessary in drawing conclusions from data which are necessarily fragmentary. In three cases he succeeded in establishing new and important facts. The results of an examination (1848) of some remarkable specimens of *Stigmaria*, the root of *Lepidodendron* and *Sigillaria*, were long accepted in text-books. They have, however, since been modified by Williamson's discovery that what Hooker had worked upon was not the actual structure but an inverse cast of it. This, however, did not affect the fact established by him, that the rootlets derive their vascular supply from the main axis. In the same year he threw much light on the morphology and anatomy of *Lepidostrobus*, the strobilus of *Lepidodendron*, and Robert Brown in 1851 records the interesting

fact that Hooker had demonstrated to him "the discovery of spores in an admitted species of *Lepidostrobus*." His most masterly achievement was the detection (1854–5) of the true nature of *Trigonocarpon*, a seed-like body not infrequent in the Coal Measures. This is now recognised as the seed of a Pteridosperm. The resemblance which it bears to the seed of *Salisburia* and of Cycads, pointed out by Hooker, has been confirmed by recent research.

In 1854 Hooker wrote to Darwin, "From my earliest childhood I nourished and cherished the desire to make a creditable journey in a new country, and write such a respectable account of its natural features as should give me a niche amongst the scientific explorers of the globe I inhabit, and hand my name down as a useful contributor of original matter" (M.L., vol. 1, p. 70). It must seldom happen that the wish of childhood is so completely and admirably realised in after life. It was a fortunate circumstance that the Earl of Carlisle was Chief Commissioner of the Department of Woods and Forests, to which both Kew and the Geological Survey were attached, and that both the Hookers were known to him. Dr. Falconer, Superintendent of the Calcutta Botanic Garden, had suggested the exploration of the Central and Eastern Himalayas, and Humboldt warmly supported it. Lord Carlisle, on the ground of securing the prospective collections for Kew, obtained Hooker a grant from the Treasury of £400 per annum for two years, and the expedition assumed the character of a Government mission. Lord Auckland, the First Lord of the Admiralty, wished him after India to go to Borneo at the Government expense "for the purpose of reporting on the capabilities of Labuan," and he received a commission in the Navy. With Lord Auckland's death the project fell through, but he was allowed £300 for a third year in India. The Admiralty sent him out on H.M.S. Sidon, which conveyed to Egypt Lord Dalhousie, the Governor-General of India, who from this point attached Hooker to his suite and subsequently procured him admission into Sikkim. While resident there he was for some time the guest of Brian Hodgson, the Buddhist scholar and naturalist, to whom he was indebted for much assistance and information. Hooker, with Dr. Campbell, the Governor-General's agent, was imprisoned by the Sikkim Court in the hope of bringing some influence to bear in a dispute with the Indian Government; but he fortunately escaped the ill-treatment to which his friend was subjected. He was able to explore part of Eastern Nepal in which no traveller has since succeeded in following him.

The expedition was rich in results, and not least remarkable for the versatility which Hooker displayed in obtaining them. He surveyed the passes into Tibet, a task of no small difficulty, seeing that it was accomplished single-handed and in a mountainous region of extreme complexity. Later travellers have only confirmed the accuracy of his work. The Lhasa Mission in 1903 derived such aid from its use that, having reached Khambajong, where it was no longer available, Sir Frank Younghusband sent Hooker a

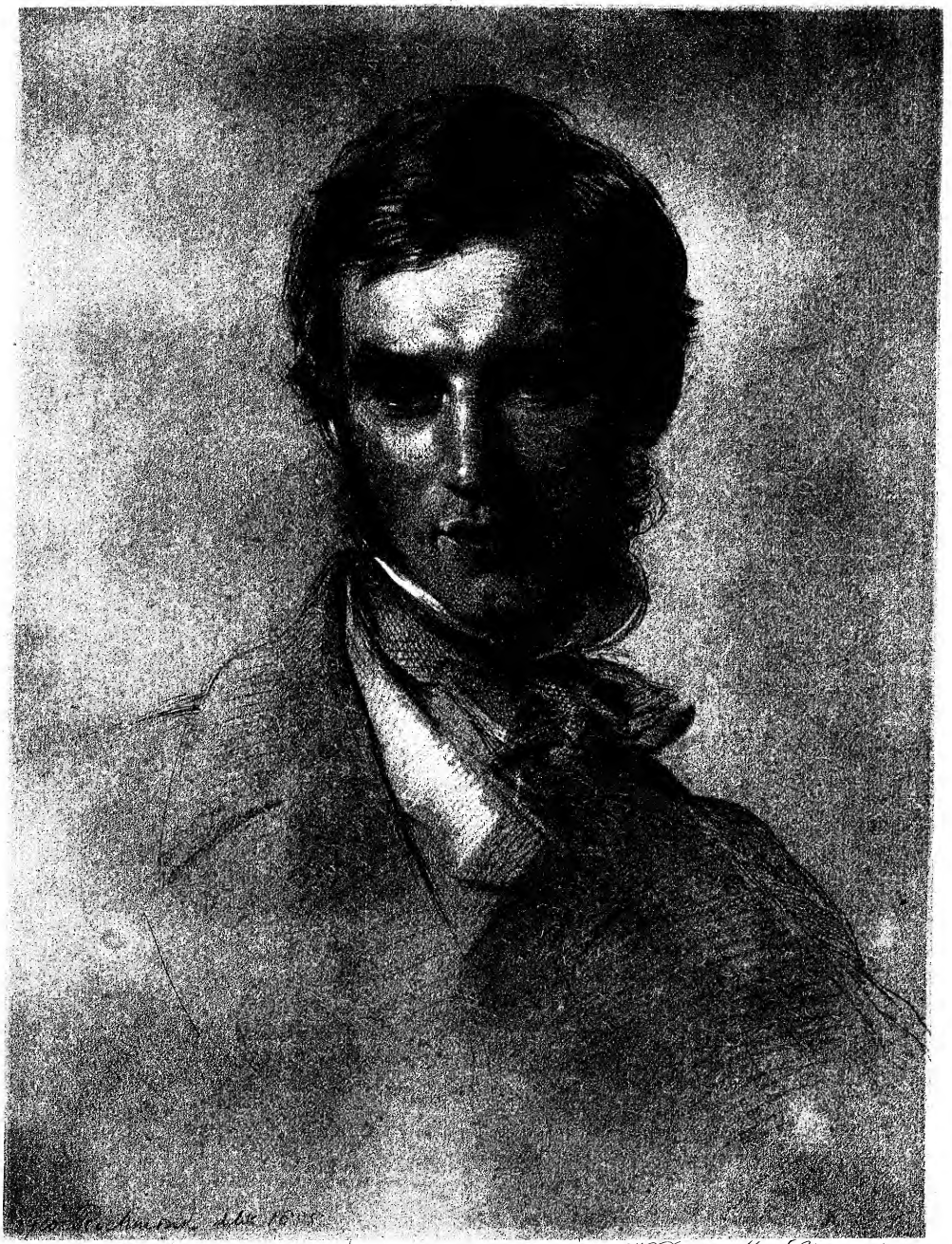
congratulatory telegram. This, with pardonable pride, he hung framed in his dining-room. Hooker's geological observations were the first (as they are still a principal) source of our knowledge of the physical structure of Sikkim. He had had "a very extensive experience of ice in the Antarctic Ocean," and in the Himalayas he was confronted with glacial phenomena on the largest scale. He thought that "very few of our geologists appreciate the power of ice as a mechanical agent" ('Him. Journ.,' vol. 2, p. 121). He gives a clear explanation of the terracing of mountain valleys, like the "Parallel Roads of Glen Roy," as the beaches of glacial lakes. He appears to have sent this home to Darwin with some expectation of publication. Both he and Lyell thought the "evidence ought to have been given more distinctly" (L.L., vol. 1, p. 376). But at this time Darwin held the view, which Lyell adopted, that the Glen Roy terraces were the result of marine action. Hooker seems to have felt discouraged, and spoke "of giving up Geology" (M.L., vol. 2, p. 152). But twelve years later (1861) Darwin had abandoned his early theory and wrote significantly to Hooker, "It is, I believe, true that Glen Roy shelves (I remember your Indian letter) were formed by glacial lakes" (M.L., vol. 2, p. 190). Hooker by continued and laborious observations laid the basis of the meteorology of Sikkim. He succeeded in introducing into cultivation through Kew its splendid Rhododendrons, which were worthily illustrated from his drawings in a work edited by his father (1849–51) and published during his absence. 1850 was spent in travelling with his old Glasgow class-mate, T. Thomson, in Eastern Bengal and the Khasia Hills, returning to England the following year. A vast collection of some 6000 to 7000 species of plants represented by copious duplicates was brought back. The Treasury made him a grant of £400 annually for three years to name and distribute his specimens (some sixty herbaria in Europe, India, and the United States were recipients), and to write the 'Himalayan Journals,' which appeared in 1854, and were dedicated to Darwin; never, probably, were the results of an expedition dealt with so swiftly or so rapidly made available for work of permanent scientific value. Darwin declared it to be "a first-class book." Douglas Freshfield, in dedicating to Hooker (1903) his own, describes him as "the pioneer of mountain travel in the Eastern Himalaya," and as "still our chief authority on Sikkim." It is singular how few have been tempted to follow his footsteps. They might have been so, for Freshfield writes, "The only European who had stood on Chungjerma before me, Sir Joseph Hooker, has described the scenery and the effects of atmosphere he witnessed on the road in what is perhaps the most eloquent passage in his admirable volumes" (p. 196).

In 1855 Hooker published 'Illustrations of Himalayan Plants,' from drawings at Kew, made at Darjeeling, at the expense of J. F. Cathcart, including *Hodgsonia*, the gigantic Cucurbit which he dedicated to his friend Hodgson. He had now been able to resume work on his Antarctic collections, and (1853–5) published the 'Flora Novæ-Zelandiæ,' forming the second instalment of the 'Botany of the Antarctic Voyage.' On its completion

the Government of New Zealand awarded him an honorarium of £350, and subsequently commissioned him to reproduce it in the more convenient 'Handbook' (1864–7).

Huxley has stated that "the facts of variability, of the struggle for existence, of adaptation to conditions, were notorious enough" anterior to the publication of the 'Origin' (L.L., vol. 2, p. 107). This is true enough as to the second and third, but by no means the case as regards the first. In 1852 Herbert Spencer had grasped the principle of the "struggle for existence," and was always surprised that he had not also deduced from it the "obvious corollary" of natural selection, or, as he called it, "survival of the fittest." But he found an explanation of his not having done so in the fact "that I knew little or nothing about the phenomena of variation" ('Autobiogr.,' vol. 1, p. 390). Nor is this to be wondered at; Linnæus had ignored it, and Hooker in the Introductory Essay to the 'Flora Novæ-Zelandiæ' (p. 8) could say, in 1883, "I am not acquainted with a British or Continental Flora which attempts to give a general view of the variation and distribution of the species described in it." We owe it entirely to Hooker's precept and example that no work of the kind is published now without it.

Variation being the indispensable material for natural selection to work upon, it is not surprising that Darwin had early suggested its study to Hooker. And though Darwin could say in 1857, "What a splendid discussion you could write on the whole subject of variation" (L.L., vol. 2, p. 90), the Introductory Essay and the application of its principles in the Flora itself, broke down once for all the Linnean principle of specific invariability. Hooker showed that it had only been maintained at all by treating "every minute character" as of specific value; the standard of specific distinction would therefore widely differ even in allied genera. Hooker's "plan," which marks a turning point in descriptive botany, was to give specific characters "the same relative value." The result would be that, while some species would be sharply defined, others would be an assemblage of closely allied forms. He saw that variation was of two kinds: one which was spontaneous and not explicable; the other, due to the direct action of external causes. As regards the first, he thought "we must ultimately adopt much larger views of the variation of species than heretofore," but was not prepared to admit that it would "obliterate specific character." As regards the latter, he thought that "climatic differences . . . often induce change"; that "a sufficient time may isolate" them; and that "such races frequently retain their character even when they have been under cultivation for many years." But he points out that the argument in favour of species being created from the fact that they are often "nicely adapted" to climate is vitiated by the evidence of geographical distribution, that they frequently exist under widely dissimilar climatic conditions. There is no trace here of any recognition of the part played by natural selection. Darwin pointed out that no theory as as to the "origin of species" makes "any difference in descriptive work"



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(M.L., vol. 1, p. 453). Though striving to arrange species according to their affinity, it deals with them as existing facts. Hooker therefore proceeds on the assumption that species are permanent, but guards himself by saying that this was not to be "interpreted . . . . as a fixed and unalterable opinion."

In reviewing the facts of distribution in the Southern Hemisphere, he insists on the inefficiency of known means of transport for seeds, and expresses the belief, which he had only hinted at before, that the presence of the same species in separate Antarctic islands could only be explained by their having been parts of a continuous area now partially submerged. He extends this theory to explain the presence of a South American element in the New Zealand flora.

In 1855 Hooker was appointed to the Kew Staff as Assistant Director, and for the next thirty years of his life he remained attached to it. With T. Thomson he had commenced a 'Flora Indica,' and the first and only volume was published in this year. But it was projected on too vast a scale to be practicable, and the work was only accomplished when resumed in later life on a more restricted plan. The first attempt was not, however, fruitless. It included an "Introductory Essay," which was published separately. This contains a "Summary of Labours of Indian Botanists," which is still indispensable, and a masterly "Sketch of the Physical Features and Vegetation of the Provinces of India," which required substantially little modification at his hands fifty years later, when the whole flora had been systematically worked out.

The great problem which never ceased to occupy Hooker's mind from his earliest work on the Antarctic flora was "the laws of the distribution of plants," and he approached it by a purely inductive method. The ascertainment of the facts must precede any attempt to theorise about them. He would give no countenance to "loose theories on geographical distribution and on the development of species" (Intr. Ess., 'Fl. Ind.,' p. 102). Though acquainted with the progress of Darwin's speculations and constantly assisting him with information, his attitude was one of continual criticism and reserve. Darwin would accuse himself of "mere base subservience and terror of Hooker and Co." (L.L., vol. 2, p. 335). "Adios," he wrote to Hooker in 1858, "you terrible worrier of poor theorists" (M.L., vol. 1, p. 105). Darwin's theory must fit in with geographical distribution, and Darwin agreed that that would be a test (L.L., vol. 2, p. 78). Meanwhile, Hooker more than once insists "that progress in this branch of botany depends on an exact knowledge of species, genera, and families, and their affinities" (*loc. cit.*, p. 103), and to this he henceforth devoted himself.

It is to be remarked that in this essay he expresses the opinion that the principle of the struggle for existence amongst plants, the first enunciation of which he attributes to Dean Herbert, had "never been sufficiently appreciated" (p. 41). "Species in general do not grow where they like best, but where they can best find room." The facts of Indian vegetation led him

to anticipate œcology, the study of plants in their social relations, which is a modern outcome of the Darwinian theory. He notes that he found some forty species on a "tree-stump on the damp, exposed hill-tops of the Khasia." He continues: "It is almost impossible, however, to appreciate the nicely balanced local circumstances that determine the number of species which will all find room and keep, and in a limited space" (p. 92). It was on such cases that Darwin founded one of the strongest arguments, if a somewhat subtle one, for his theory. "The truth of the principle that the greatest amount of life can be supported by great diversification of structure is seen under many natural circumstances ('Origin,' 6th Edition, p. 88).

Besides permanent and transitory variation, he now recognises a third class: "There are accidental variations due to no apparent causes or to very fluctuating ones" (p. 30). This is probably the first use of the word fluctuating in connection with the kind of variation to which it is now generally applied.

There was a gradual approximation to Darwin's own point of view. Huxley (L.L., vol. 2, p. 196) quotes a letter from Lyell to Sir Charles Bunbury, written April 30, 1856: "When Huxley, Hooker, and Wollaston were at Darwin's last week, they (all four of them) ran atilt against species —further, I believe, than they are prepared to go." Huxley adds: "With regard to Hooker, he was already like Voltaire's Habbakuk, *capable de tout* in the way of advocating evolution." But a belief in evolution as a fact, and a conception of how it is effected, are by no means identical. He was still some way from accepting Darwin's solution.

It is probably unique in the history of science for the author of a far-reaching theory, which ultimately meets with general acceptance, to keep it for twenty years as a secret to himself and to a few intimate friends, and meanwhile to occupy himself in testing its validity in every possible way, and in building up argument in its support. Such reserve would in any ordinary case be perilous if the claims of priority were of any importance. But Darwin found that, as soon as the necessary consequences of the theory were appreciated, the opposition it would encounter would be so violent that no pains would be thrown away in making the evidence in its favour as far as possible unassailable.

Lyell had warned him that he would be forestalled. On June 18, 1858, he received from Wallace, who was then in the Celebes Islands, an essay containing what was substantially his own theory, and it came upon him, as Wallace said, "like a thunderbolt from a clear sky." The position became tragic, for, on June 29, Darwin was prostrate with illness; scarlet fever was raging in his family, and an infant son had died of it the day before. Lyell and Hooker acted for him; an extract from the MS., shown to and read by Hooker in 1844, was communicated with Wallace's essay to a meeting of the Linnean Society on July 1. This itself was an exceptional occasion, for it was a special and postponed meeting in consequence of the death of Robert Brown. The new theory was launched over the grave of the most distinguished botanist of his time.

Darwin was forced to what, according to Wallace, "he considered a premature publicity." This, in the interests of science, was perhaps not an unmixed evil. For, with feeble health, it may be doubted if he would ever have achieved the series of works in which he intended to promulgate it. He was obliged immediately to prepare an abstract, the 'Origin of Species,' which appeared in 1859. This had, at any rate, the advantage that it gave the theory to the world with a summary, in the most concentrated form, of the facts and arguments which seemed to the author to support it.

But it had another effect. Darwin's friends, who had been in his confidence, had now to decide one way or the other. Hooker gave a general adhesion at once, though with some reserve. He would doubtless have done so earlier, if to do so would not have been to force Darwin's hand. Writing to Hooker on Christmas Day, 1859, he said, "I do think I did you a bad turn by getting you to read the old MS., as it must have checked your own original thoughts" (L.L., vol. 2, p. 252). This has since been published (1909) by Francis Darwin in 'The Foundations of the Origin of Species.' In August, 1854, in case this abstract might prove, in the event of his death, to be the only record of his work, he had made a note: "Hooker by far best man to edit my species volume" ('Foundations,' p. 28). The fact that Hooker had read it as early as 1844, when it was written, saved the situation. There is no evidence that a knowledge of its contents hampered his own progress to evolutionary theory. He had to clear his path of obstacles which were peculiar to his own subject; difficult as it may be to appreciate the fact now, the doctrine of "multiple origins" hung round the neck of botanists like a millstone. A result of its avowed or tacit acceptance was, to use Hooker's words, "the too prevalent idea that the plants of newly discovered, isolated, or little-visited localities must necessarily be new." The resulting incubus of synonymy he described as "the greatest obstacle to the progress of systematic botany;" and he gave copious illustrations from the Indian flora. The evil can only be remedied by comparing new material in large herbaria; in no other way can the geographical distribution of a species be arrived at.

In 1859, however, Darwin was able to write to Wallace: "Hooker, who is our best British botanist, and perhaps the best in the world, is a full convert, and is now going immediately to publish his confession of faith" (M.L., vol. 1, p. 119). But, writing to Hooker, he said: "I have spoken of you . . . . as a convert made by me; but I know well how much larger the share has been of your own self-thought" (L.L., vol. 2, p. 176). The conversion must have been fairly rapid at last, for Darwin had written to him the year before "not to pronounce too strongly against natural selection" (L.L., vol. 2, p. 138).

The 'Flora Tasmaniæ,' completing the 'Botany of the Antarctic Expedition,' was published in parts between 1855 and 1860. To the first volume, issued in 1859, is prefixed an introductory essay, "On the Flora of Australia: its origin, affinities, and distribution." This is by far the most important and

remarkable of all Hooker's speculative writings. Published in June, it anticipated by four months the appearance of the 'Origin of Species,' to which it served as a most efficient advanced guard.

He avoids any precipitate advocacy, and takes a purely judicial view—"matured conclusions on these subjects are very slowly developed." "I have hitherto," he says, "endeavoured to keep my ideas upon variation in subjection to the hypothesis of species being immutable," as a check "to careless observation of minute facts." He finds "the aspect of the question materially changed," and proceeds "to review, without reference to my previous conclusions, the impression which I have derived from the retrospect of twenty years' study of plants." He points out that he had long insisted on the importance and prevalence of variability, and "how deep it lies beneath the foundation of all our facts and reasonings concerning classification and distribution." He now saw that the "mutual relations" between species were "analogous to those between the lineally descended members of a family," and that "this indeed is the leading idea in all natural systems." Both distribution and classification had unconsciously led botanists towards evolution. When it was once grasped that similarity in species implied a common ancestor, it became possible to form some theory to explain the presence in any one country of elements characteristic of others though not identical.

The essay contains a masterly analysis of the Australian flora. Seven-eighths of its species were found to be entirely confined to it. Bentham four years afterwards described it as "the best exposition I am acquainted with of the geographical relations of the flora of any country." When he had completed in 1878 his own 'Flora Australiensis,' in which he described the species in detail, he found no ground for modifying Hooker's conclusions. On the completion of the work Hooker received an honorarium of £350 from the Tasmanian Government.

The 'Origin of Species' soon removed from Hooker's mind any doubt as to the efficiency of natural selection. Darwin wrote to Hooker in 1862 to say that "my present work is leading me to believe rather more in the direct action of physical conditions. I presume I regret it, because it lessens the glory of natural selection" (M.L., vol. 1, p. 214). Hooker, however, was now eager to exalt it. Writing to Bates ('River Amazons,' p. 43) he said, "I am sure, with you as with me, the more you think the less occasion you will see for anything but time and natural selection to effect change; and that this view is the simplest and clearest in the present state of science." Darwin remarked on the correspondence, "It is really satisfactory to me to see so able a man as Bates (and yourself) believing more fully in natural selection than I think I even do myself" (M.L., vol. 1, p. 199). Hooker, however, thought that variation was paramount and, in writing to Bates, "enough with time to beget any amount of change," and he adds: "Variation I hold to be centrifugal; if it were not so, how could it go on making species, which are only the preserved forms of each brood which

circumstances favoured?" On this Darwin commented: "I rather demur to your doctrine of centrifugal variation" (M.L., vol. 1, p. 199), and seemed to think that it conflicted with his "Doctrine of Diversification." This is the principle already mentioned, that the greatest amount of life can be supported by great diversification of structure ('Origin,' 6th Ed., p. 88). Hooker's own observations in the Khasia had taught him this. His own point was different, and the explanation he gives, "the best marked varieties of a wild species occurring on the confines of the area the species inhabits," is undoubtedly the fact that proves the point. Both Hooker and Darwin rejected the popular belief that species which had varied could revert to the original type. In other words, evolution is not a reversible process, as Hooker clearly saw. F. Darwin in discussing the point observes that this does not conflict with Galton's "Regression to Mediocrity," which is a "centripetal tendency." For that only applies to a population which interbreeds freely, where the amount of variation always regresses to what Galton terms the median value. Such regression tends to wipe out variability and to establish racial stability. But the median is itself subject to variation and to natural selection.

The essay on the Australian flora has so far been dealt with only as an apologia for Hooker's position with regard to Darwinian theory. As was rightly stated on the occasion of the award to him of the Copley Medal, "it effected a revolution" in respect to the rational basis on which he placed geographical botany. De Candolle in his monumental work, 'Géographie Botanique Raisonnée,' published in 1855, only four years before the 'Origin,' left the problem unsolved. Asa Gray remarks truly, "De Candolle's great work closed one epoch in the history of the subject, and Hooker's name is the first that appears in the ensuing one."

In 1881 Hooker made Geographical Distribution the subject of his address as President of the Geographical Section at the Jubilee meeting of the British Association at York. He showed that from Linnæus onwards the distribution of plants was regarded as dependent solely on physical conditions. Meyen, for example, in his 'Geography of Plants' (1836), of which the Ray Society published a translation in 1846, lays down that "conditions of climate, particularly heat and moisture, are the chief causes which determine the station and distribution of plants" (p. 8). Hooker in this address pointed out that such conclusions failed to give any explanation of the occurrence of similar organisms "when there is no discoverable similarity of physical conditions, and of their not occurring in places where the conditions are similar" (p. 7). Dependence on physical features was still, however, maintained by Grisebach in 1872.

In the concluding pages of the essay on the Australian flora Hooker briefly states the general conclusions at which he had arrived as to the actual facts of plant distribution and of their origin in the past. These have become classical and the basis of all subsequent speculation. The "general indications," which, as Bentham pointed out, we owe to Hooker,

were amplified by himself into a more detailed survey in his 1869 address to the Linnean Society. Hooker insisted on the distinctness of the two great Northern and Southern floras. While admitting that they may have had a common origin in the past, it could not have been "within comparatively modern geological epochs." He puts them in striking contrast. The Northern occupies a vast land surface from which it has sent down invading streams in every direction southwards; its "tendencies" are "usurping." The Southern, on the other hand, is broken up into three subordinate floras in dissevered areas; its northward migration, if it be one, and not as Darwin thought a retreat, is feeble. It appears to be doomed to extinction, and everywhere we see its peculiar forms "dying out in small areas." They are subject in fact to the nemesis of excessive specialisation, which implies a greater antiquity. They will succumb before "that power of appropriation in the strife for place" in which Hooker saw a "force . . . of the real nature of which power no conception has been formed by naturalists, and which has not even a name in the language of biology" (p. civ). Hooker singled out as notable the "continuous current of vegetation" which extends from Scandinavia to Tasmania, "the greatest continuity of land" "of the terrestrial sphere," and the next in importance the Himalayan along the same arc, dying out in Malaya. The former he worked out (1862) in great detail in his classical memoir, "Outlines of the Distribution of Arctic Plants" ('Trans. Linn. Soc.,' vol. 23, pp. 251–348). He showed that "the Scandinavian vegetation . . . in every longitude . . . migrated across the tropics of Asia and America" (p. 253). Few now probably will accept Darwin's explanation that this took place during a refrigeration of the tropics; the facts established by Hooker remain, however, unshaken. Darwin in this and other cases sometimes indulged in hazardous deductive speculation; Hooker relied on laborious inductive investigation. The result was to place plant distribution on an entirely new basis. The flora of a country could no longer be regarded as the outcome of local physical conditions, but was derivative from a former order stretching back into a remote past. The gulf between the two conceptions is immeasurable.

In 1866 (August 27) Hooker delivered before the British Association at Nottingham his celebrated lecture "On Insular Floras." This was published at the time in the 'Gardeners' Chronicle,' but not separately printed (without alteration) till 1896. He indulged in an amusing allegory to represent the celebrated discussions at Oxford (L.L., vol. 3, p. 48) in which he had been called on to take part, and had triumphed over the Bishop of Oxford's ignorance "of the elements of botanical science" (L.L., vol. 2, pp. 322–3). He thought that "neither geological considerations, nor botanical affinity, nor natural selection, nor all these combined, have yet helped us to a complete solution of this problem, which is at present the *bête noire* of botanists" (p. xv). He concluded that "the hypothesis of trans-oceanic migration, though it leaves a multitude of facts unexplained, offers a rational explanation of many of the most puzzling phenomena that oceanic islands

present—phenomena which under the hypothesis of intermediate continents are barren facts" (p. 33). Darwin thought the arguments for occasional transport were given with perfect fairness and would receive a fair show of attention as coming from a professed botanist (L.L., vol. 3, p. 48).

In the essay on the flora of Australia, Hooker pointed out that "there is a strict analogy . . . between the floras of islands and those of lofty mountain ranges" (p. xv). He then thought that the "species and genera common to . . . distant localities" could only be explained by "conditions which no longer exist." The subject long continued to interest him. In papers in the 'Journ. Linn. Soc.' he discussed (1862) the plants of Clarence Park, 10,000 feet, and of the Cameroons (1864), 13,000 feet. In the appendix to 'Morocco and the Great Atlas' (1874) he summarised the results. This was the first study of the vegetation of any African mountains outside Abyssinia. He ascertained the remarkable fact of "the preponderance of Abyssinian genera and species"; this was "proved by almost all of the genera and half the species being natives of Abyssinia," 2000 miles distant. Darwin thought this a "wonderful case," and confirmation of his belief "that the whole world was cooler during the Glacial Period" (M.L., vol. 1, p. 477). In 1874 he similarly discussed the first collection made on Kilimanjaro. This was found to be mainly South African in affinity, but with species common to the Cameroons on the one hand and Abyssinia on the other. Thus was again established a connection at high levels across the tropics, but in the reverse direction to that of the Scandinavian, of the great Southern and Northern temperate floras. It is noteworthy that in 1847 Hooker had been sceptical as to the existence of mountains in Central Africa at all ('Ant. Fl.,' p. 210). It was to Robert Brown that the first detection of a South African element in Abyssinia was due (*loc. cit.*).

Hooker had now played his part, and felt that he had played it, in the great campaign. He wrote to Darwin in October, 1859, to say that he now intended "sticking to humdrum science." The intention was deliberate, though Darwin ridiculed it as impossible. Hooker had been appointed Assistant Director at Kew as a lieutenant to his father, to whom he was deeply attached. He would certainly stand at his right hand during his lifetime, and there was probability amounting to certainty that he would be called upon to succeed him. His lot was therefore cast in with Kew, and this he saw clearly involved scientific duties and responsibilities which Darwin imperfectly apprehended. Kew had been organised both as the national headquarters of botanical investigation and as a consultative department of the Government in colonial enterprise. If the two functions are correlative, the latter may sometimes handicap severely the former.

The central feature of the Kew organisation is the vast herbarium, of which the foundations were the unsurpassed collections accumulated by Sir William Hooker, and purchased by the Government after his death. The elder Hooker had always held consistently that a herbarium was

essentially an instrument of research, and that a vital activity was a necessary condition of its usefulness. The continuance of this policy has led to the enormous development of the Kew Herbarium by bequests and the continuous influx of collections made by travellers and explorers. The problem which had for some time weighed on Hooker's mind was how to improve the classification of this vast amount of material and throw it into a form more available for detailed research.

For the preceding two centuries botanists had seen that the first step in a sound classification of the vegetable kingdom was to gather species into genera. The difficulty was to discard characters which were superficial and to decide on those which correctly indicated a true affinity. The task commenced by Linnæus had been in a great measure accomplished by the logical spirit and method of the French school. In the early part of the last century Endlicher had attempted to review the whole field with indifferent success. Hooker and Thomson ("Introd. Ess.," 'Fl. Ind.,' p. 10) could only lament that "so eminent a botanist . . . . has thought it necessary to encumber his pages with characters of genera which must for ever remain enigmatical, unless some happy chance should make us acquainted with the specimens of the authors." Hooker felt that this sort of compilation at second hand was worthless for any scientific end. A further and no less serious defect in current taxonomy was the absence of any uniform standard. "A knowledge of the relative importance of characters can only be acquired by long study; and, without a due appreciation of their value, no natural group can be defined. Hence, many of the new genera which are daily added to our lists rest upon trivial characters, and have no equality with those already in existence." This may be taken to heart by those who are disposed to estimate lightly the value of taxonomic work. Its successful prosecution depends not merely on an insight into morphology, but still more on a judicial power of co-ordinating evidence. John Stuart Mill bears eloquent testimony to its value as a discipline in this respect. Jeremy Bentham does no less, and it is scarcely too much to say that a study of the methods of "classification in natural history" stimulated him in the pursuit of an ideal jurisprudence.

In 1860, Hooker commenced with his friend George Bentham (Jeremy Bentham's nephew) the 'Genera Plantarum,' and it occupied them continuously for the succeeding quarter of a century. The first portion was issued in 1862, the concluding in 1883, Bentham only surviving its completion till the following year. The two worked together, but the major part of the task was borne by Bentham, who, having independent means, was not subject to the official and other calls upon his time which hampered Hooker. It is to be noted that the work was written throughout in the Latin language, and the title, 'Genera Plantarum ad exemplaria imprimis in Herbariis Kewensibus servata definita,' establishes the fact that it is entirely based on material which is open to any subsequent investigator for verification.

Something must be said as to the individual qualities of the partners in

this memorable achievement. Bentham, trained in the French school, brought to the work those elements of form, precision, and logical method which have never been surpassed. To this he added, in the words of Prof. Oliver, "an insight of so special a character as to deserve the name of genius, into the relative value of characters for practical systematic work, and, as a consequence of this, a sure sifting of essentials in each respective grade." Hooker's strong point, on the other hand, was a keen appreciation of the value of morphological characters as a guide to affinity. Reichenbach found in his work "that touch of genius which resolves difficult questions of affinity where laborious research has often yielded but an uncertain result" (Copley Award). Hooker's share, therefore, exhibits more originality, and he felt some disappointment that this had not received the recognition it undoubtedly deserved.

Darwin at first could not "help being rather sorry at the length of time it must take" (M.L., vol. 2, p. 281), but twenty years later thought it "a great misfortune for science" that Hooker could not devote more to it (M.L., vol. 2, p. 433). Its merits found universal recognition. It was described abroad as a work worthy of German laboriousness and of more than German accuracy. Perhaps the most signal estimate of its value is that it has been freely drawn upon by every succeeding writer in the same line. Incidentally, it is a mine of information on Geographical Distribution which has never yet been utilised. The area occupied by each genus is carefully worked out. Casimir de Candolle has made some attempt to tabulate the data, but merely states verbally the conclusion that the origin of existing phanerogamic vegetation was intertropical. It appears from a letter of Darwin's in 1870 (M.L., vol. 1, p. 323) that at that time Hooker contemplated "some general work on Geographical Distribution," and it is an irreparable loss to science that he was never able to give effect to his intention.

In 1873 he edited 'A General System of Botany,' a translation by his first wife from the 'Traité Général' of Le Maout and Decaisne, in which he rearranged the Dicotyledonous orders according to the sequence adopted by Bentham and himself. For the Monocotyledons he devised a new classification of his own.

In 1861 Henslow, Hooker's father-in-law, and Darwin's "dear old master in Natural History" (L.L., vol. 2, p. 217), died. The reverence that is compatible with the keenest scientific criticism of belief may be measured by the noble letter which Huxley wrote to Hooker. A sentence may be quoted: "I can faintly picture to myself the great and irreparable vacuity in a family circle caused by the vanishing out of it of such a man as Henslow, with great acquirements, and that great catholic judgment and sense which always seemed to me more prominent in him than any man I knew" (H.L.L., vol. 1, p. 226).

On November 3, 1864, the *x* Club was started. It consisted of nine scientific men, all intimate friends, but whose occupations gave them otherwise

little opportunity of keeping in touch. The arrangement was to dine on a Thursday in each month on which the Royal Society met. Three of the members were destined to be Presidents in succession, and three Copley medallists. It was the opinion of the smoking room of the Athenæum that "they govern scientific affairs, and really, on the whole, they don't do it badly." Huxley repudiated this, and thought the "tone of our ordinary conversation" was "sadly frivolous" (H.L.L., vol. 1, p. 259). There was doubtless a method in the frivolity. Anyhow the club was a power, and the nine formed a sort of dynasty while it lasted; and dynastic vigour has its merits. It died out in 1893. Hooker, as well as Huxley, was also a member of "The Club," and occasional attendance at its dinners was in later life one of the few social pleasures he allowed himself (H.L.L., vol. 1, p. 259).

He had never lost his interest in glacial phenomena. July of 1865 was spent in Teesdale, and the result was a paper on 'The Moraines of the Tees Valley.' On August 12 his father died. The circumstances were tragic: the illness was sudden; Hooker sent to London for the best advice, but to no purpose. He relates, "I saw him no more, for, sleeping on the floor by his bedside that night under an open window, I was suddenly prostrated with rheumatic fever." Hooker succeeded to the directorship, and for the next twenty years administrative duties of the most varied kind limited still more the time available for scientific work. Official scientific positions in this country are apt to be regarded as sinecures; perhaps this is because their occupants often achieve as much as more leisured men.

The elder Hooker had carried the Government with him in a wave of enthusiasm in reorganising Kew on a scale worthy of a national establishment. It was not, therefore, to be expected that Hooker's directorship would be signalised by any great undertakings of equal magnitude. Much, however, was done in detailed development, and some notable features were added. In 1869 the "New Range" replaced eight obsolete "stoves," and in 1877 a new wing relieved the intolerable congestion of the Herbarium. Various additions were the result of liberality independent of the Government. The Jodrell Laboratory was built (1876) at the expense of T. J. Phillips Jodrell, to give effect to a recommendation of the Commission on Scientific Instruction and the Advancement of Science "that opportunities should be afforded for the pursuit of investigations in Physiological Botany." It has amply fulfilled its purpose, and has been the scene of much memorable work. The North Gallery, completed in 1880, was erected at the expense of Miss Marianne North, to contain the pictures which she had made of tropical vegetation in various parts of the world. In the following year an extension was made to the Museum, at the expense of the India Office, to allow space for the botanical collections removed from the Indian Museum, and the Rock Garden was formed to receive the collection of Alpine plants bequeathed by George Curling Joad, F.L.S. A hailstorm on August 3, 1879, was the greatest trial to which Kew has

been subjected; 38,649 panes were smashed into 18 tons of broken glass, and the damage required for its repair a supplementary estimate in Parliament. In 1876 the introduction of the Para rubber tree into our Eastern Colonies was successfully accomplished, though not without considerable difficulty. A quarter of a century elapsed before it was seen to contain the "potentiality of growing rich beyond the dreams of avarice."

Hooker's personal hobby was the development and extension of the Arboretum, or collection of ligneous plants grown in the open air. This had been commenced by his father, and he spared no pains in enlisting the aid of correspondents at home and abroad in enriching it. Nor was he less anxious to have them correctly named, and the often deplorable confusion in their nomenclature cleared up. Elwes and Henry, in their great work, 'The Trees of Great Britain and Ireland,' have reaped a rich harvest from Hooker's labours. He finished planting the Pinetum in 1870; there was no part of the establishment which he revisited with more pleasure after his retirement. The Arboretum contains between 4,000 and 5,000 species; with all the disadvantages of an infertile soil and of London fog, it is probably without a rival in any other country.

Hooker carried on two periodicals illustrative of Kew work. The 'Botanical Magazine,' founded in 1787, had been edited by the elder Hooker from 1824. It consists of figures of new and interesting cultivated plants, and, after the association of the magazine with Kew, its collections chiefly supplied the materials. Hooker conducted it till 1904, writing mostly the descriptions himself. The "Icones Plantarum" had been started by the elder Hooker, and afterwards passed into Bentham's hands. It consists of figures of interesting and novel plants drawn from the Herbarium. Hooker edited the third series.

These were not the only burdens which a Kew position placed on Hooker's shoulders. The Government had given early encouragement (and some pecuniary aid) to the Hookers in the publication of Floras of British Possessions. The first of these was the elder Hooker's 'Flora Boreali-Americana' (1829–40). But this, like those included in the botany of the Antarctic voyage by the younger, were "on too expensive a scale to be generally useful." This led to Sir William Hooker suggesting in 1857 that the series should be continued in 8vo volumes in the English language, "scientific, yet intelligible to any man of ordinary education." The plan was adopted and sanctioned by the Duke of Newcastle in 1860. The scheme necessarily required the co-operation of many hands. Hooker co-operated actively. He assisted Thwaites in his 'Enumeratio Floræ Zeylaniæ' (1864), produced a 'Handbook of the New Zealand Flora' (1864–7), based on his own previous work, and edited a second edition of Harvey's 'Genera of South African Plants' (1868). In 1870 he published 'The Student's Flora of the British Islands' (3rd Edition, 1883) much on the same lines. This would have been the first British Flora to give the external geographical distribution if the 'Compendium' of H. C. Watson had not been published

somewhat earlier in the same year. Hooker's original plan was large, but proved impracticable. Darwin, writing in 1868, said "It is a splendid scheme, and, if you only make a beginning on a Flora, which shall serve as an index to all papers on curious points in the life-history of plants, you will do an inestimable good service" (M.L., vol. 2, p. 373). He hoped at some time "to undertake such a task, in the form of a companion," but never accomplished it. In some degree, Lord Avebury's 'Notes on the Life-History of British Flowering Plants' (1905) fills the gap.

No very long time elapsed before the India Office also expressed the wish that the Indian Possessions of the Empire should be included in the scheme. In 1872 Hooker, acting under "instructions" from the Duke of Argyll, issued the first part of a 'Flora of British India.' Though on a more modest scale than the abortive attempt made by himself and Thomson in 1855, it was not completed, even with the assistance of many contributors, for a quarter of a century. But this will be referred to later. In 1877 he saw through the press Baker's 'Flora of Mauritius and the Seychelles.'

Something of personal history must be resumed. In 1860 Darwin wrote to Hooker, "Huxley is eager about a 'Natural History Review' which he and others are going to edit, and he has got so many first-rate assistants that I really believe he will make it a first-class production" (L.L., vol. 2, p. 328). It was an Irish venture transferred in a second series to England. Darwin told Huxley that, "I (Huxley) ought not to waste myself in other than original work" (H.L.L., vol. 1, p. 210). During its short but brilliant career—it died in 1865—Darwin was enthusiastic and even contributed a review. There is no doubt it was a very effective weapon in smiting what Huxley called the Amalekites (*loc. cit.*, vol. 1, p. 215). He regarded Hooker "as art and part of the 'Natural History Review,' though not ostensibly one of the gang" (*loc. cit.*, vol. 1, p. 237), and professed to be in terror of being "blown up" by him (*loc. cit.*, vol. 1, p. 246).

In the autumn of 1860 Hooker was invited by Captain (afterwards Admiral) Washington, the Hydrographer of the Navy, to accompany a scientific expedition to Palestine, to which Daniel Hanbury was also attached. This must have been thought to be not free from risk, even to so experienced a traveller. For Darwin called it astonishing (M.L., vol. 1, p. 166), implored him not to "get your throat cut," and thought he "must be a little insane" (L.L., vol. 2, p. 337). There seems to have been no adventure. One outcome was the well-known paper on "Cedars" in the 'Natural History Review.' They afforded a problem which Hooker had more than once discussed: a species with subordinate races in widely dissevered areas: Himalaya (Deodar), Syria (Lebanon), and Africa (Atlas). Nothing was accurately known previously of the grove on Lebanon, which he found to occupy an old moraine 4000 feet below the summit, which is no longer covered with perpetual snow. He thought that in a colder period the cedar would have descended to a lower level and been continuous through Afghanistan and Persia with the Himalayan race.

J. M. Cameron, 1868.

W. Dennis Moss, Cirencester.

Returning to more personal events, Hooker gave in 1866 the lecture on "Insular Floras" at Nottingham, which has already been discussed. In the following year he made a brief excursion to Brittany with Huxley and Lord Avebury to examine pre-historic remains. Nothing refreshed him so much as a holiday of this sort with some scientific interest in view. In 1870 he went with Huxley to the Eifel; Tyndall would have been of the party, but was detained by his lectures. In 1873 he took Huxley, who had been seriously ill, to Auvergne. They visited the four volcanic areas explored by Scrope, and roughed it with all the hardihood of experienced travellers. Huxley was none the worse for sleeping on one occasion on two planks in a cupboard (H.L.L., vol. 1, p. 392). The friends thought that they had made a great discovery in the evidence of glacial action. Hooker published an account in 'Nature,' but found that he had been anticipated by Sir William Guise in 1870. In 1867, besides working out *Rosaceæ* for Martius' 'Flora Brasiliensis,' he edited a posthumous volume of his friend Boott's 'Illustrations of the Genus *Carex*.'

In 1868 Hooker was President of the British Association at Norwich. Darwin wrote that the address was received by the Press with "a chorus of praise," and that he himself thought it "most striking and excellent" (L.L., vol. 3, pp. 100–1). Hooker had, needlessly in the event, urged in extenuation of any shortcomings, want of leisure in the discharge of "duties as administrator of a large public department, entailing a ceaseless correspondence with the Government offices, and with botanical establishments all over the globe." He managed to touch on a wide range of important scientific questions. He lamented the failure of museum management to grasp its educational possibilities—and he might lament still. He reiterated the opinion, "shared by an overwhelming majority of British naturalists," that the National Collection of Natural History should be under the control of a scientific head, and this has come about. He dwelt with satisfaction on the fact that the ten years that had elapsed since the appearance of the 'Origin' found Natural Selection "an accepted doctrine with almost every philosophical naturalist." He thought Darwin's "new hypothesis of Pangenesis . . . may prove to contain the rationale of all the phenomena of reproduction and inheritance." The prevision was more correct than he really suspected to be probable; for as recently as 1909 Strasburger could say, "Charles Darwin's idea that invisible gemmules are the carriers of hereditary characters, and that they multiply by division, has been removed from the position of a provisional hypothesis to that of a well founded theory. It is supported by histology, and the results of experimental work in heredity, which are now assuming extraordinary prominence, are in close agreement with it" ('Darwin and Modern Science,' p. iii). Hooker thought that there were some who "will prefer embodying the idea in such a term as potentiality, a term which conveys no definite impression whatever, and they will like it none the less on this account." He was really quietly laughing at himself, for this is precisely what he and Huxley had propounded

to Darwin, to whom it gave no comfort (L.L., vol. 3, p. 81). No doubt Pangenesis was in advance of its time, but, if we may measure the merit of a hypothesis by the depth of insight into the phenomena which it attempts to explain, Pangenesis is a greater intellectual feat than even Natural Selection itself.

The promulgation of Darwin's theory left Hooker's outlook on his own work substantially unaltered. But with Lyell the case was different. Though he did not realise it, we must agree with Huxley that, "consistent uniformitarianism postulates evolution as much in the organic as in the inorganic world" (H.L.L., vol. 1, p. 169). Darwin fully admitted his own personal debt, for in the dedication of the 'Journal' he says: "The chief part of whatever scientific merit this journal and the other works of the author may possess has been derived from studying the well-known and admirable 'Principles of Geology.'" Huxley emphasises this: "Darwin's greatest work is the outcome of the unflinching application to Biology of the leading idea and the method applied in the 'Principles'" ('Roy. Soc. Proc.,' vol. 44, p. viii). There can be few positions more tragic in life than that of the master who is confuted by his disciples from his own teaching. Yet this was Lyell's fate, and his conversion was slow and painful. In a passage which Darwin thought "felicitous and eloquent" (L.L., vol. 3, p. 101) Hooker did him justice. "I know no brighter example of heroism, of its kind, than this, of an author thus abandoning, late in life, a theory which he had for forty years regarded as one of the foundation stones of a work that had given him the highest possible position attainable amongst contemporary writers. Well may he be proud of a superstructure raised on the foundation of an insecure doctrine, when he finds that he can underpin it and substitute a new foundation; and, after all is finished, survey his edifice, not only more secure, but more harmonious in its proportions than it was before."

In 1869, at the instance of the Government, he attended the International Botanical Congress at St. Petersburg.

In 1871, Hooker, accompanied by his friends John Ball, the botanist, and George Maw, geologist, made (April to June) an important and successful expedition to Morocco, a country which, as he said then, "though close to Europe, is amongst the least known regions of the earth." He had been inspired with the idea of visiting it by Captain (afterwards Admiral) Washington, whom he accompanied to Syria in 1860, and who was "one of the very few Europeans who had reached the flanks of the Great Atlas Chain" (1829). The scientific problem which presented itself to Hooker was to "explore the great Atlas, to become acquainted with its vegetation, and to ascertain whether this supplies connecting links between that of the Mediterranean regions and the peculiar flora of the Canary Islands." Beyond the first two chapters, Hooker's other occupations prevented his writing the 'Journal of a Tour,' and it was completed by Ball (1878), but he supplied appendices in which he stated his botanical conclusions. The mountain flora of Morocco proved to be "a southern extension of the

European Temperate flora" (p. 445). The remarkable and unexpected fact was ascertained that the Alpine-Arctic flora had failed to cross the Western Mediterranean. The Great Atlas furnished "no gentian, no primrose or *Androsace*, no rhododendron, no anemone, no potentilla, and none but lowland forms of saxifrage and ranunculus" (p. 230). As to the Macaronesian flora, Hooker was finally "disposed to regard it as a very distinct subdivision of the Mediterranean province," in which "types once common to West Europe and North Africa" have been eliminated (p. 421).

The expedition was not free from difficulty and even danger, but escaped mishap. The Moroccan Government in assenting to an exploration of the Great Atlas stipulated that the ridge should not be crossed into the Sous Valley. The highest point reached was the Tagherot Pass (11,483 feet), which had never been reached before by any European. Incidentally they found that the practice of sacrificing animals as a propitiatory rite survived amongst the Berbers, and they were themselves on one occasion the object of it, in the hope of securing through their influence the release of men imprisoned by the Moors for non-payment of taxes. It is interesting to note that Hooker and Ball formed and expressed the conviction that "the one reasonable prospect of improvement in the condition of Morocco is to be sought in its passing under the control of a civilised state," and that it should be France (p. 351).

Kew had been re-organised under the Department of Woods and Forests with almost lavish generosity. In 1850 it passed to the control of the Office of Works, to which officially it was only a "Pleasure Ground," and which never felt much sympathy for its scientific character and functions. It is not wholly surprising, therefore, that in 1872 Hooker had what have been euphemistically described as "protracted differences" with Ayrton, the First Commissioner. Sir Algernon West, Gladstone's private secretary, claims to have "made peace between them," and thought Ayrton the "more reasonable man of the two" ('Recollections,' vol. 1, p. 14). That may have been the official view; but the differences were not adjusted without debates in both Houses of Parliament. The scientific world saw clearly that the real question involved was the breaking up of Kew as a scientific establishment, and gave Hooker its unflinching support. What was perhaps of more importance was that both Kew and Hooker were popular; public opinion declared itself on his side; Gladstone transferred Ayrton to another office, and the electorate dismissed him at the General Election in 1874 from political life.

In 1873 the Royal Society removed from the restricted accommodation it had received in Burlington House to the building it at present occupies in the Quadrangle. Hooker was elected President, Huxley being a joint secretary. It was to be expected that the association of two men of strong individuality and intense devotion to the interests of science should leave their mark on the work and history of the Society. Hooker's first aim was to bring it more into touch with the social life of the community. Tentative and

informal evening receptions were held, and the success of these induced the Council in 1875 to establish the annual Ladies' Soirée.

In 1874 Hooker suffered a terrible blow in the sudden death of his wife (Henslow's eldest daughter) on November 13, without the smallest warning, and while he was away from home. This prevented him from presiding at the Anniversary Meeting, and what Huxley described as the "acephalous condition" of the Society cast a gloom over the following dinner. Mrs. Hooker was a singularly gifted woman, and what her companionship and help had been to her husband needs but a single illustration. When Darwin in 1854 received the 'Himalayan Journals,' he wrote, "I feel sure that the time will never come when you and Mrs. Hooker will not be proud to look back at the labour bestowed on these beautiful volumes" (L.L. vol. 1, p. 392).

Attention had been drawn to the limitation of admission to the Society by one of the Fellows at the Anniversary Meeting in 1874, and Hooker took "the earliest opportunity of submitting it to the deliberations of the Council." No change was made beyond taking away from peers and restricting to Privy Councillors the privilege of being proposed for election without being subject to selection. It was still thought that the association of scientific workers with "men of signal eminence in statesmanship, art, or letters was generally desirable." Hooker, like others, would probably have regretted that the foundation of the British Academy in great measure superseded this.

In 1876 the Challenger returned from the voyage round the world "originated" by the Royal Society and "crowned with complete success." In 1872 Hooker had drawn up suggestions for Moseley as to what might profitably be done in plant-collecting in the course of an expedition whose objects were oceanic research. Opportunity was well utilised, but it was thought advisable "to limit the Botanical Reports to a review of Insular floras, which came within the range of the expedition" ('Narrative,' vol. 1, p. 943). This was carried on at Kew with Hooker's advice in the 'Botany,' vol. 1, published in 1885. Hooker was Chairman of the Committee of Publication of the Reports, which sat from 1876 to 1895, and was responsible for the production of 50 illustrated volumes, the work of of 76 authors, at an expenditure defrayed from public funds of some £50,000. The result was probably unique in the history of expeditions.

In 1878 he laid down the office of President. He was "influenced by the consideration that, though wholly opposed to the view that the term of the Presidency of the Royal Society should be either short or definitely limited, this term should not be very long." But his main reason was the pressure of "official duties" and "scientific engagements." In his Anniversary Address, he made an announcement which gave him peculiar pleasure. The fact is singular that the Royal Society has never possessed more than a slender endowment. The amount of the fees contributed by the Fellows "occasionally prevented men of great merit from having their names brought forward as candidates." It was found that a sum of £10,000 would be "required for effecting any material reduction." This sum Hooker raised

privately and almost single-handed in about a fortnight. He would tell the story of how, having got £1,000 from his old Glasgow friend, James Young, who had made a fortune from the Torbane Hill mineral, he communicated the fact and his object to the common friend of both, Sir Joseph Whitworth, and received the reply, "Not to be done by Jimmy," and a cheque for £2,000.

The address being in a sense valedictory, Hooker devoted it to a luminous summary of the striking achievements of science during the period of his Presidency. In dwelling more particularly on botanical advance, he could urge with truth "the excuse that there is, perhaps, no branch of research with the early progress of which this Society is more intimately connected," and he could point to the fact that vegetable histology began with Hooke and Grew, and cytology with Robert Brown.

This was in other ways a period of intense activity. In 1874 Hooker presided over the Department of Zoology and Botany of the British Association at Belfast. He chose, as the subject of his address, "The Carnivorous Habits of some of our Brother Organisms—Plants." This was a notable performance, as it was his one incursion into physiology. He reviewed all the known instances, and demonstrated from his own observations the occurrence of proteid digestion in pitcher-plants (*Nepenthes*), of which he had been the monographer. He concluded: "Though the processes of plant-nutrition are in general extremely different from those of animal-nutrition, and involve very simple compounds, yet . . . the protoplasm of plants is not absolutely prohibited from availing itself of food, such as that by which the protoplasm of animals is nourished, under which point of view these phenomena of carnivorous plants will find their place as one more link in the continuity of nature." The subject is of great theoretical interest, for it points to the fact that chlorophyllian assimilation from inorganic compounds, on which plants mainly depend, is a habit acquired since the primary stem of plant-life diverged from the primordial stock.

In 1877, at the close of the session of the Royal Society, Hooker obtained an extended leave of absence, to accept an invitation from Dr. Hayden, United States Geologist-in-charge of the United States Geological and Geographical Survey of the Territories, "to visit under his conduct the Rocky Mountains of Colorado and Utah, with the object of contributing to the record of the survey a report on the botany of those States." Prof. Asa Gray and Sir Richard Strachey were also members of the party. The Anniversary Address for 1877 was mainly devoted to a general account of the survey, with an indication of the particular problem which his own share in its work might throw light upon. This problem had been raised by Gray in 1858, when he first pointed out that the Asiatic affinities of the North American flora were to be found, not, as might be expected, on the Pacific, but on the Atlantic side of the Continent. Hooker's solution was first given in a lecture at the Royal Institution on April 12, 1878. The whole problem is too intricate to allow of more than the barest summary of its data. Comparing North America with Europe, it is obvious that in the one the

mountain chains are longitudinal, in the other latitudinal. Florida is consequently exposed to northern blizzards, from which the European Riviera is immune. The Miocene flora had a circumpolar extension. It was driven south during the Glacial period. Practically exterminated in Europe, it partially survived in Eastern Asia, where the glaciation was less severe. Owing to its greater elevation the Glacial period was more intense and more prolonged in Western than in Eastern North America; in the former the Miocene flora was exterminated with a few exceptions such as *Sequoia* in California, and its place was ultimately taken by a flora of Mexican origin; in the latter it returned northward after a temporary retreat. The whole subject was discussed in detail by Hooker in a report published by the Department of the Interior of the United States Government in 1881.

He had secured the attachment of naturalists to the Transit of Venus Expeditions sent out in 1874, and the Rev. Mr. Eaton went to Kerguelen's Land, which had also been visited by the Challenger earlier in the same year, and where Hooker had himself collected in 1840. In 1879 he again discussed all the available material ('Phil. Trans.,' vol. 168). The Fuegian affinities of the flora were confirmed. "Winds almost throughout the year, blow from Fuegia to Kerguelen Island . . . . but appear quite insufficient to transport seeds over 4,000 miles." He still leaned, "as the forlorn hope of the botanical geographer," to his early belief in the former existence of more land between the two. On the other hand the remarkable fact which he had pointed out in 1875 ('Linn. Journ.,' vol. 14), that the scanty vegetation of Amsterdam Island and Tristan d'Acunha, 3,000 miles apart, "approximates to that of South Africa," may be due to transport by land-birds. He points out that "no trace of the mountain flora of South Africa has been found in any of the southern group of islands." And this is unfavourable to their having had any land connection with South Africa on the one hand, or a hypothetical northward extension of the Antarctic Continent on the other.

The 'Genera Plantarum' was completed in 1883, and with the eighties Hooker began a determined attack on the 'Flora of British India.' This was partly a labour of love, partly a service which he felt Kew had long owed to the Indian Empire. He had utilised the co-operation of other botanists, but gradually took the whole burden on to his own shoulders; vol. 3 appeared in 1882 and vol. 4 in 1885. About that time he showed some symptoms of failing health. He had never been content to live less than a full life, and this his medical advisers decided could not continue. He resigned the Directorship in 1885 and retired to a house he had built for himself at Sunningdale. While this relieved him of official routine and social distraction it enabled him to work at Kew several days a week in the room in the library formerly occupied by Bentham. Under more tranquil conditions health was happily completely restored. The 5th volume of the Flora was finished in 1890; the 6th in 1894, including the *Orchidaceæ*, to which he devoted two years' work, and the 7th in 1897.

In 1904, at the request of the India Office, he contributed to the

3rd Edition of the 'Imperial Gazetteer,' "A Sketch of the Flora of British India." While he found little occasion to modify what he had written forty years earlier, he was able to summarise the results of the Flora. The number of species of flowering plants actually described "approaches 17,000." In 1855 Hooker had concluded ('Intr. Ess.,' p. 91) that "*Orchideæ* appear to form a larger proportion of the flora of India that of any equally extensive country." This was verified, the number of species being some 1300, and with few exceptions these are peculiar to it. Previous conjecture had regarded *Leguminosæ* and *Gramineæ* as relatively deficient, but they proved to be the next largest elements in the flora. As regards the former this is not surprising, as in most large areas it is dominant. *Compositæ*, the largest of all orders of flowering plants, fill a subordinate place, as in most tropical countries. In 1905 Hooker furnished the descriptions to the plates of a "Century of Indian Orchids," in the 'Annals of the Royal Botanic Garden, Calcutta.'

In 1885, the last year of his directorship, he summarised, in the 30th Edition of the 'Official Guide to the Royal Botanic Gardens and Arboretum,' the work done under his superintendence since 1870, on replanting the Arboretum, and incidentally gave an admirable and critical account of the most important and interesting elements of the collection. In 1902 the number of hardy trees and shrubs enumerated in the 2nd Edition of the 'Hand-list of Trees and Shrubs (excluding Coniferæ)' amounted to about 4500. Hooker had contemplated the preparation of a catalogue of the Kew Pinetum. He drew up an introduction which, after revision by himself, was prefixed to the 'Hand-list of Coniferæ' in 1896.

In 1886 he worked out, in a paper contributed to the Linnean Society, the material of species of *Castilloa*, which had been obtained for the purpose of more accurately determining the source of Central American rubber.

In 1887 he revised the 5th Edition of Bentham's classical 'Handbook of the British Flora.' (He did the same with subsequent editions up to the 8th, in 1906.) Darwin tried its use and was "charmed with it" (L.L., vol. 2, p. 132). There can be no better book for those who begin the study of British plants, and no better introduction to the principles of their classification. Hooker's own 'Student's Flora' is better suited to those who are more advanced.

From 1886 to 1897, as has been seen, Hooker was continuously occupied with the three remaining volumes of the 'Flora of British India,' with such assistance as the Kew staff could give him in the preliminary arrangement of material. It was not to be expected that the period could be prolific in other ways. But he managed to devote an immense amount of time and labour, which it might have been wished he could have spared himself, to another task which in some degree he felt affection imposed upon him. Shortly before his death Darwin had expressed a wish, by aiding "in some way the scientific work carried on" at Kew, to show "his gratitude for the invaluable aid which for so many years he received from its Directors and its staff" (L.L., vol. 3, p. 352). The result of Darwin's munificence was the

'Index Kewensis.' Darwin had found the usefulness in his own work of Steudel's 'Nomenclator Botanicus,' an alphabetical list of specific names of plants, with their native countries. This, since its publication in 1841, had fallen completely out of date. Sir William Hooker, however, had commenced having an interleaved copy continuously posted up, and this had been carried on for the use of workers in the Herbarium. Darwin thought that it might be printed; but this was not found to be altogether practicable. Hooker having associated with himself John Ball and several members of the Kew staff, it was decided to base the work on the 'Genera Plantarum,' to which it would serve as a complement, and to give under each genus the published species, with the place of publication and their native countries. The work was entrusted to Mr. Daydon Jackson, who was occupied upon it for ten years. Printing was commenced in 1892 and completed in 1895. Hooker "most generously devoted an immense amount of time to the herculean and monotonous task of revision, and . . . . brought his vast personal knowledge to bear on the independent but by no means inconsiderable task of settling the geographical distribution" ('Kew Bull.,' 1893, p. 343). The result has been described justly as "a work with regard to which the feeling is one of incapacity to understand what its absence implied."

Hooker edited, in 1896, the journal kept by Sir Joseph Banks during Cook's first voyage round the world, which Admiral Wharton had described in his own preface to Cook's 'Journal' as "to the English nation the most momentous voyage of discovery that has ever taken place." Hooker's object was "to present him as the pioneer of those naturalist voyagers of later years, of whom Darwin is the great example." Dawson Turner, Hooker's maternal grandfather, who had been a friend of Banks, had undertaken to write his life, a task he never accomplished. Two of his daughters made a transcript of the 'Journal,' the original of which Hooker saw as a boy in 1833, when he was "fascinated" with it, and "never ceased to hope that it might one day be published." Banks' papers were for some time in the custody of the British Museum, but were ultimately sold by Lord Brabourne. Beyond the fact that Banks' Journal was purchased by a dealer for £7 2*s.* 6*d.*, its ultimate fate was unknown. As has since been ascertained, it has found an appropriate resting-place in the Mitchell Library at Sydney. The Turner transcript was retained at the British Museum, and Hooker was allowed to have it copied. In preparing it for the press he freely excised what was the mere record of trivial daily occurrence, and some matter too anthropological for general publication. The manuscript copy upon which he worked was presented by Mr. Reginald Hooker, who assisted his father, to the Kew Library.

Having finished the 'Flora of British India' as already stated, Hooker took up the completion of Trimen's 'Handbook to the Flora of Ceylon,' left unfinished by the author's death. This he completed in 1900, and in the 'Imperial Gazetteer of India' gave his final conclusions on the Indian flora in 1907.

His last literary effort was to fulfil a wish long entertained to write 'A Sketch of the Life and Labours' of his father, for whose memory he always cherished a deep affection ('Ann. of Bot.,' 1902). He dwells on "the solicitude with which he fostered my own aspirations to become a traveller and a botanist." It is rare in personal history for the lives of father and son to form a continuous whole. It was a relationship where, to use his own words, "one soweth, another reapeth."

Robert Brown was no less distinguished as a morphologist than as a systematist. Hooker, who took his place in English science, might have had equal fame in both had not his interest in classification and distribution been dominant. But his early palæontological work, in which the problems are purely morphological, proves that he had the root of the matter in him. No one, in fact, can accomplish anything fundamental in classification who has not the morphological instinct, and all through life the detailed study of plants with aberrant and peculiar structure always attracted him. His classical memoirs on *Balanophoreæ* (1856 and 1859), a group of parasitic and consequently highly reduced flowering plants, almost simulating fungi, raised a question as to the homology of the female flower, which he thought could only be solved by the study of its development, but as to which 25 years afterwards he was not disposed to alter his views. The knot is now cut by regarding reduction as having been carried to a point where all homology has disappeared. In 1857 he discussed the anomalous floral structure of *Siphonodon*. In 1859 he took up the study of *Nepenthaceæ*, a family which he monographed for De Candolle's 'Prodromus' in 1873. His theory of the pitcher (which was reproduced in French) as the expansion of an apical leaf-gland is, in different terms, that substantially accepted. In 1863 he produced his great paper on *Welwitschia* ('Linn. Trans.,' vol. 24) (reproduced in German and Portuguese), which alone would have made the fame of most botanists. Asa Gray thought that it was "the most wonderful discovery, in a botanical point of view," of the century, and that Hooker had "enjoyed (and improved) an opportunity unequalled by any botanist since that which placed *Rafflesia* in Mr. Brown's hands."

This extraordinary plant in its extravagant anomaly is unique amongst ligneous plants. Its stem instead of growing vertically expands horizontally like a huge fungus half buried in the sands of South Africa, on which it throws out its single pair of strap-shaped leaves. These grow continuously from the base, to die off at the apex; Hooker not unnaturally regarded them as permanent cotyledons. In 1880, when seedlings had been raised at Kew, Bower found that this was not the case, and that the actual cotyledons were extremely fugitive, while the permanent leaves were a second pair at right angles to them. This, though important and accepted by Hooker ('Gen. Pl.,' vol. 3, p. 1224), in no way diminished their anomalous character. It is noteworthy that in after years Hooker had occasion to describe species of a widely different South African genus, *Streptocarpus*, in which the single leaf is actually an enormously developed cotyledon.

That was a time of stress; Hooker wrote to Darwin, "I am plodding away at *Welwitschia* by night and 'Genera Plantarum' by day" (M.L., vol. 1, p. 467), Darwin thought he was over-working (*l.c.*, vol. 2, p. 284). The problem was to determine the affinity underlying such extreme adaptive disguise. Darwin said, "I see plainly that *Welwitschia* will be a case of Barnacles," *i.e.*, the *Cirripedia*, his own study (M.L., vol. 1, p. 213). As an archaic survival it "seems to be a vegetable *Ornithorhyncus*, and, indeed, more than that" (M.L., vol. 2, p. 281). Hooker placed it in *Gnetaceæ*, a perplexing group standing midway between Gymnosperms and Angiosperms, and there it remains. Later botanists have disputed as to the nature of the ovular integuments; but it may be doubted whether this involves more than verbal distinctions.

Hooker was now more and more absorbed by his larger undertakings, and could spare little time for researches not ancillary to them. Two may be mentioned. In 1875 he made a careful study of *Prosopanche*, of which a solitary South American species represents the strange African parasites, *Hydnora*. He contributed to the 'Annals of Botany' in 1887 a description of *Hydrothrix*, a new genus of *Pontederiaceæ*, which had escaped notice in the 'Genera,' founded on an amphibious Brazilian plant, exceptional amongst its allies in its single-stamened flowers.

Balsams (*Impatiens*) had always attracted Hooker, no doubt from the morphological interest of their floral structure, and the extreme difficulty of studying it in a dried state, which makes them the despair of herbarium students. He described the Indian species in 1860 and worked them over again for the 'Flora of British India' in 1875, and once more for the 'Records of the Botanical Survey of India,' from 1904–6. The genus continued to furnish the recreation and occupation of his remaining years. Hooker turned his attention to China, which, when opened up to collectors, proved extremely rich in new species of the genus. Foreign herbaria were only too glad to put their material at his disposal. The results of his studies, published from time to time, were the subject of no less than 14 papers. In one in French, contributed in 1908 to the 'Nouvelles Archives du Muséum,' he described the species in the Paris Herbarium. He was then able to say that, while in 1862 135 species were known, he was now able to recognise some 500. The difficulty of the task he had imposed upon himself may be judged from his remark: "Celui qui étudie ce genre sur le sec apprend vite qu'il n'y a pas de plus grand difficulté pour un systematicien que l'analyse, la coordination et la description des *Impatiens*." The process of soaking and laying out the flowers for examination was extremely tedious and required great skill; "chaque pli doit disparaitre; et cela souvent est une opération si longue qu'une heure et souvent deux ou trois suffisent à peine pour une fleur." Hooker still continued his work on *Impatiens*, till his forces finally failed him, and its last instalment, with dissections drawn, as in others, by his own hand, did not appear till shortly after his death. He was unable to frame a classification which entirely satisfied him, but he was able to establish the remarkable fact that the species are grouped in geographical

areas which only rarely have any in common. It is obvious that we have in *Impatiens* a case of specific evolution, which deserves and awaits further and profound study.

Hooker was twice married: first, 1851, to Frances Harriet (died 1874), eldest daughter of Rev. John Stevens Henslow, by whom he left four sons and two surviving daughters; second, 1876, to Hyacinth, only daughter of Rev. W. S. Symonds, widow of Sir W. Jardine, seventh baronet (died 1874), by whom he left two sons.

Hooker was 5 feet 11 inches in height, and throughout life spare and wiry in figure. In 1859 Huxley wrote to him: "Don't let all the flesh be worried off your bones (there isn't much as it is)." There was a touch of the "quarter-deck" in his carriage. With a fresh complexion, there was in later life a general ruggedness in his aspect, and he was somewhat indifferent as to his personal appearance. Those who knew him in middle age think the published photograph by Mrs. Cameron most characteristic. There are portraits by Collier at the Royal Society and by Herkomer at the Linnean. Huxley wrote of this in 1859 (H.L.L., vol. 2, p. 232), "You were never quite so fat in the cheeks," and quizzed him about the fur coat; it certainly gave an aldermanic effect wholly foreign to him. The portrait has been reproduced. There is a bronze medallion modelled from life by Frank Bowcher.

Great powers of physical endurance carried him through his travels with no permanent injury to health. His temperament was nervous and high-strung, and he could not stand petty worries, especially those incidental to official life. A somewhat strict disciplinarian, he always retained the sense of official subordination, which he had no doubt learnt in his naval service. He was careful to note that he acted "under instructions," and would speculate as to what the "Board" would say in the smallest administrative details. His outlook in life was calm and philosophic; science and its progress was his absorbing and single-minded interest. He would spare no pains to advance it. The *x* Club kept him in touch with what was being done outside his own subject. Geographical research was with him a passion only second to botany. Had he not been a great botanist, he might have been an even greater geographer.

He had a great gift for securing and retaining friendship, which was helped by a keen sense of humour and an admirable gift in letter-writing, which he doubtless inherited from his maternal ancestors. He was a vivacious conversationalist, fond of paradox for the sake of stimulating discussion, but was little prone to draw on his past experiences.

He was nervous about public speaking, but when pushed could make an excellent speech, rising to some eloquence. That when his health was proposed as Copley Medallist was a notable performance, reviewing with a dignified modesty the "incidents that directed my own scientific life," and concluding that they "are fruitless, if there is not some inward motive power to compel us to exercise our faculties, and some inward heat, some fervour, to ripen the fruits of our labours." In his own case, he was content

to have found it in the motto of Prince Henry of Portugal, the father of navigation, "talent de bien faire"—"the wish to do well."

His literary style in early life was laboured and sometimes obscure, but later became nervous and precise, and he was singularly happy, especially in technical matters, in seizing the felicitous and pregnant word. Though as a young man he had beguiled a tedious journey through the Sundarbans with Tennyson's "Princess," poetry had no appeal to him in after-life. But artistic tastes, inherited from both parents, were not atrophied. He was an accurate and more than ordinarily skilful draughtsman. He was an ardent collector of Wedgwood, and the severity of Flaxman's line and composition particularly appealed to him. He derived much pleasure at home and abroad from the older masters, and much admired the modern French school before its later developments. He continued to enjoy music of a classical type throughout.

A few words may be said to indulge a reasonable curiosity as to the physical conditions of a life in which so much was accomplished and which was so prolonged. He was very abstemious and smoked only moderately, but never at work. He could dispense with sleep to a remarkable extent. In his prime he would work till two, to wake at five and read in bed till seven, a habit he had contracted as a student. On the outward voyage the Erebus stopped at Madeira, and Hooker eagerly explored its flora. Sleeping out under a tree he contracted rheumatic fever. The Antarctic voyage must have tried him, followed by the labour of working out its results, for Darwin reminded him in 1860, "that you were bad enough before your Indian journey" (L.L., vol. 2, p. 203). The "troubled heart-action" about which Darwin wrote to him seriously the previous year (M.L., vol. 1, p. 98) was doubtless due to the rheumatic fever. Of this he had a more severe and happily final attack in 1865 when he was carried in blankets by four men to see from a window his father's body leave the house. In 1885 there was a return of heart trouble and marked deterioration of the arteries. His retirement from official life was followed by complete restoration to health, which was henceforth undisturbed except by some troublesome gouty ailments in his last years. His mental powers retained unabated vigour and activity to the end. The summer of 1911 enfeebled him. What seemed a temporary illness compelled him at the last to remain in bed. In the last week he asked that the account of the Royal Society dinner should be read to him. The day of his death excited no anxiety. He passed away in his sleep at midnight on December 10.

The Dean and Chapter of Westminster offered, with public approval, the last supreme honour of burial in the Abbey. It would have been fitting that his ashes should be placed near Darwin. But at his own expressed wish he was taken back to Kew, the scene of his labours, and there on December 15 he was laid to rest in the grave which contained the remains of his father and of his first wife.

Hooker's long life was, as it deserved to be, punctuated with honours. He received honorary degrees from Oxford, Cambridge, Dublin, Edinburgh, and

Glasgow. In 1869, after his Presidency of the British Association, he was created C.B.; in 1877, at the close of that of the Royal Society, K.C.S.I.; in 1897, on the completion of the 'Flora of British India,' he was advanced to G.C.S.I. in the Diamond Jubilee list of honours, his old friend Sir Richard Strachey receiving the same distinction. In 1907, on his ninetieth birthday, the Order of Merit was handed to him personally at his home on behalf of the King. As an old naval officer he felt himself debarred from accepting foreign decorations. The apparent exception was the Order of the Polar Star; Hooker explained his position to the Swedish Ambassador and, while unable to accept the honour, was allowed to retain the decoration (H.L.L., vol. 1, p. 361). He accepted the Prussian "Pour le Mérite," but only after the King's express approval; but that, as Huxley said, "is a purely literary and scientific affair."

From the Royal Society Hooker received a Royal Medal in 1854, the Copley in 1887, and the Darwin in 1892, the second occasion of its award. The Society of Arts gave him their Albert Medal in 1883; the Geographical their Founder's in 1884, and the Manchester Philosophical the Wilde Medal in 1898. From the Linnean Society he received the Linnean Medal in 1888, one specially struck "on the occasion of the completion of the 'Flora of British India'" in 1898, and in 1908 that struck on the jubilee of Darwin's memorable communication. In 1907 he was the sole recipient from the Royal Swedish Academy of the Medal to commemorate the bicentenary of the birth of Linnæus, and this, short of the Order of Merit, which came afterwards, he regarded as "the crowning honour of his long life."

He was one of the eight Associés Étrangers of the French Académie des Sciences and a member of other scientific societies throughout the world too numerous to mention.

A life which has been contemporary with three generations requires as many portraits to show the personality which was familiar to each in succession. The earliest of those reproduced shows Hooker in his 38th year, and is reduced from a chalk drawing by George Richmond, in the possession of C. P. Hooker, Esq., of Dollarward House, Cirencester. It is reminiscent of the "most engaging young man" whom Darwin had described to Lyell eleven years earlier (M.L., vol. 2, p. 120). In middle life it has been difficult to find anything satisfactory; he was too busy to think about portraiture. Perhaps the most characteristic is Mrs. Cameron's photograph, which has been reduced. Of this Darwin wrote (M.L., vol. 2, p. 376): "I have got your photograph over my chimney-piece and like it much; but you look down so sharp on me that I shall never be bold enough to wriggle myself out of any contradiction." Though only 13 years later than the Richmond portrait, it is eloquent of the stress of official labour. The last portrait is from a photograph taken in the last year of his life in his garden at Sunningdale.

W. T. T.-D.